RAM Engineering

TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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Life Cycle RAM Activities

Pre-Milestone A/Concept Refinement

- ICD Requirements Feasibility Study
- Purchase Description Development
- Scope of Work Development (Sections C and E)
- Whole Systems Trade Studies (WSTS)
- Test and Evaluation Strategy (TES) Development
- Participate in SRR
- Analysis Of Alternatives (AoA)
- Similar System Analysis
- Trades/Gap Analysis
- T&E Strategy
- Failure Definition Scoring Criteria (FDSC)
- Reliability Growth Plan
- Source Selection

Life Cycle RAM Activities

Milestone A-B/Technology Development

- CDD Requirements Feasibility Study
- Purchase Description Development
- Scope of Work Development (sections C and E)
- TEMP Development
- RAM-D Report Development
- Participate in Design Reviews (SRR, ISR, PDR, CDR, TRR)
- Analysis Of Alternatives (AoA)
- Failure Modes Effects and Criticality Analysis (FMECA)
- Failure Definition Scoring Criteria (FDSC)
- Risk Assessment
- T&E Strategy
- Reliability Growth Tracking
- Source Selection
- RAM Test Execution
  - Test Incident Report (TIR) Review
  - Chair Scoring Conference
  - Corrective Action Review Board
  - Assessment Conferences
  - Analysis

Life Cycle RAM Activities

Milestone B-C/
Engineering & Manufacturing Development

- DT&E Results
- Participate in Design Reviews (SRR, IBR, PDR, CDR, TRR)
- Purchase Description Development
- Scope of Work Development (Sections C and E)
- TEMP Development
- Failure Definition Scoring Criteria
- RAM-D Report Development
- CPD Development
- T&E Strategy
- Reliability Growth Tracking
- Source Selection
- Developmental RAM Test Execution
  - Test Incident Report (TIR) Review
  - Chair Scoring conference
  - Corrective Action Review Board
  - Assessment Conferences
  - Analysis

Life Cycle RAM Activities

Post- Milestone C/Production & Deployment

- LRIP/ Production Contract
- PQT/PVT Results
- Source Selection
- Reliability Growth Tracking
- Operational RAM Test Execution
  - Test Incident Report (TIR) Review
  - Scoring Conference
  - Corrective Action Review Board
  - Assessment Conferences
  - Analysis
- Field and System Evaluation
  - Test Incident Report (TIR) Review
  - Initiate Cost Reductions (OSCR Project Support)
  - AMSAA / OSMIS / ILAP Data Analysis
  - ECP Assessments

Life Cycle RAM Activities

Systems Supported:

JLTV	HEMTT
PIM	MRAP
STRYKER	HMMWV
RCV	HETS
FMTV	GCV
M915A5	PLS

OTHERS

RAM – Requirements Development

- Review User's draft CDD / FDSC / OMS-MP
  - Perform Materiel Developer's Analysis using predecessor or similar system
    - Utilize previous test data, VDLS, OSMIS, Army ILAP, RAM-D summaries
    - Comparison of failure definition
    - Comparison of mission profile and weight
    - Perform state-of-art analysis
  - Determine feasibility of User's requirements for Reliability, Maintainability, and Availability
    - Mean time between failure (MTBF, MMBSA, MMBEFF, MRBF, etc…)
    - Maintenance ratio (MR), Mean time to repair (MTTR, MaxTTR, etc…)
    - Material Availability (Am), Operational Availability (Ao), Inherent Availability (Ai), etc…
  - Provide comments and reasoning for all recommendations

RAM – Requirements Development

- Establish RAM scope of test
  - Negotiate RAM test scope (Number of vehicles, number of miles, number of rounds fired)
    - To effectively prove out R&M requirements
      - while minimizing cost
      - and minimizing the schedule impact on the program
- Provide RAM input to Spec and SOW
  - Convert user's operational requirements into technical requirements for SPEC
  - Provide comments and reasoning for all recommendations
  - Develop contract language for SOW
    - Using the latest DOD guide and ASA(ALT) guideline of best reliability practice
  - Coordinate RAM contract languages among RAM IPT
- Provide RAM language to various technical documents
  - TEMP
  - SEP
  - AS

RAM Involvement during Source Selection

- TARDEC RAM Engineering provides support during source selection preparations.
- TARDEC RAM Engineering also support bid sample testing during source selection.
- During the conduct of a Source Selection Evaluation Board (SSEB), TARDEC RAM Engineers serve as subject matter experts.
- TARDEC RAM Engineers participate in face to face discussions with the proposal Offerors.
- TARDEC RAM Engineers provide SSEB result briefings to the Source Selection Authority (SSA).

RAM Support at Design Reviews

- TARDEC RAM Engineers support the following major acquisition program reviews:
  - Start of Work Meeting (SOWM)
  - System Requirements Review (SRR)
  - Preliminary Design Review (PDR)
  - Critical Design Review (CDR)
  - Test Readiness Review (TRR)
  - Program Management Review (PMR)
- Responsibilities of RAM Engineers at program reviews include:
  - Ensuring Vendor correctly interprets Purchase Description (PD) RAM requirements
  - Reviewing Vendor RAM predictions and analyses
  - Verifying that the Vendor is adequately prepared to enter formal government testing, and tracking test progress throughout the test phase

Benefits of RAM Engineer Participation at Program Design Reviews

- Benefits of having RAM representation at formal reviews:
  - SOWM/SRR: Opportunity to meet the Vendors' RAM sub-Integrated Product Team (sub-IPT) and establish strong communication. RAM engineers verify that the RAM requirements are interpreted correctly.
  - PDR/CDR: RAM Subject Matter Experts (SME) can review RAM predictions/ analyses and ask questions directly to the Vendor's RAM sub-IPT.
  - TRR/PMR: RAM engineers, Test and Evaluation IPT Chiefs, and Test Managers assess the Vendor's readiness for formal testing. Once testing has commenced, RAM Engineers can accurately report on RAM test status.

Performance and Requirement Evaluation during RAM test

- R/M Test Planning - Test Site/Sample size determination
- Pre-test meeting/test readiness meeting
- Test Data Collection/ Test Incident Report
- Army Test Incident Report (ATIR) Database and COGNOS
- Failure Analysis and Corrective Action Report
- Continuous monitor of TIRs and FACAR
- Pre-Scoring Conference and TIR review

Performance and Requirement Evaluation during RAM test

- Scoring Conference
- Failure Analysis and Corrective Action Implementation
- Continue Testing with Design Changes/Corrective Action
- RAM Assessment Conference
- Final RAM performance Evaluation
- RAM requirement calculation/verification

Scoring IPT

- Purpose: To review all TIRs generated from RAM test and establish common data base for evaluating the R/M performance of the system
- Guiding Document: FDSC (published by C D with materiel developer's input)
- Scoring IPT is made up of three voting members representing
  - Materiel Developer (PM)
  - Combat Developer (School)
  - Independent Evaluator (AEC)
- The dissenting voter can submit minority opinion
  - it gets attached to the minutes.
- Development Test Scoring IPT
  - Materiel Developer chairs the scoring IPT
- Operational Test Scoring IPT
  - Independent Evaluator chairs the scoring IPT
- Contractors can present the results of failure analysis that may assist voting members
- The scoring is government unilateral decision
- The minutes that has the official scores are published by the chairing agency.

Preparation for Scoring IPT

- During test phase scoring IPT may be held as often as few weeks depending on the program and number of TIRs
- Pre-scoring conference with contractor
  - Review of TIRs with contractor to fully take their take on each failures
  - Materiel Developer carries the burden of proof and need the maximum preparation for the scoring process
- On-line Scoring tool available (real time scoring)
  - Face-to-face meeting only for those incidents that are not agreed upon
  - Cuts almost ~60% of meeting time

Test Incident Reports (TIRs)

- Development Test
  - ATEC writes and publishes TIR for all incidents during development test
  - Testers run the test and the result of the test is technical evaluation
  - The result is evaluated against SPEC requirement
- Operational Test
  - TIRs will be written by test director (depends on OTC)
  - TIRs needs to be released by DAG (Data Authentication Group)
  - Independent Evaluator chairs the scoring IPT
  - No supplemental information is available in addition to the TIRs
  - Scoring process is similar to DT scoring
  - The result is evaluated against the User's requirement

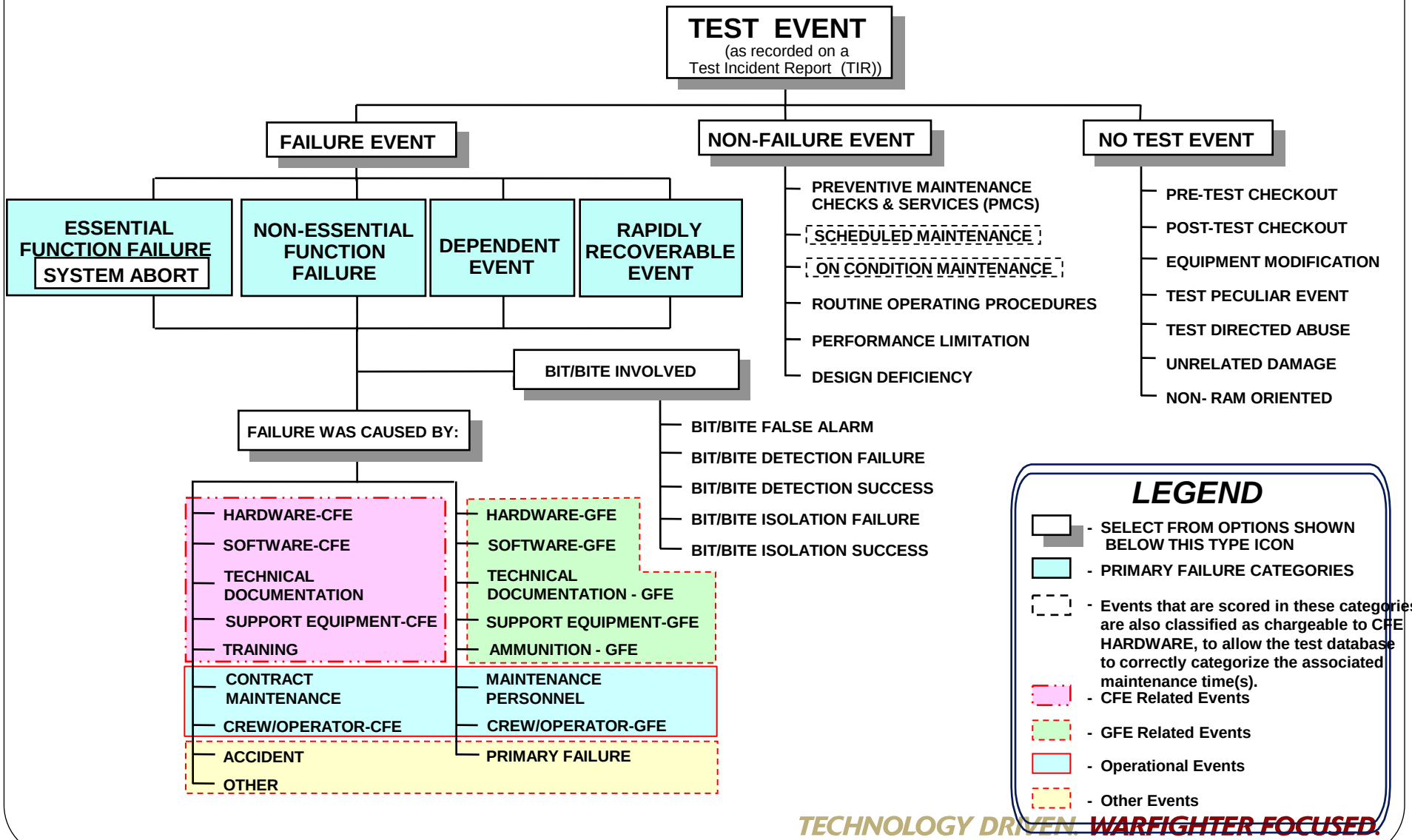
Reliability Data Analysis

- Reliability Analysis must be discussed up front and consensus should be reached on:
  - FDSC – Failure Definition Scoring Criteria
  - Failure Categories
    - Inherent vs. Induced Reliability
  - Mission Profile and Life Variable
  - Data Grouping and Modeling
  - Instantaneous vs. Cumulative Reliability

FDSC – Failure Definition Scoring Criteria

- FDSC is Contractual Document that defines
  - Failure/non-Failure Event
  - Test related Event
  - Severity of Failure as it relates to the Mission
  - Cause of the Failure
- FDSC is prepared as required by Army Regulation 70-1, Army Acquisition Policy.
- FDSC is being used through out the test for Scoring purposes, hence it is a major document for RAM Assessment

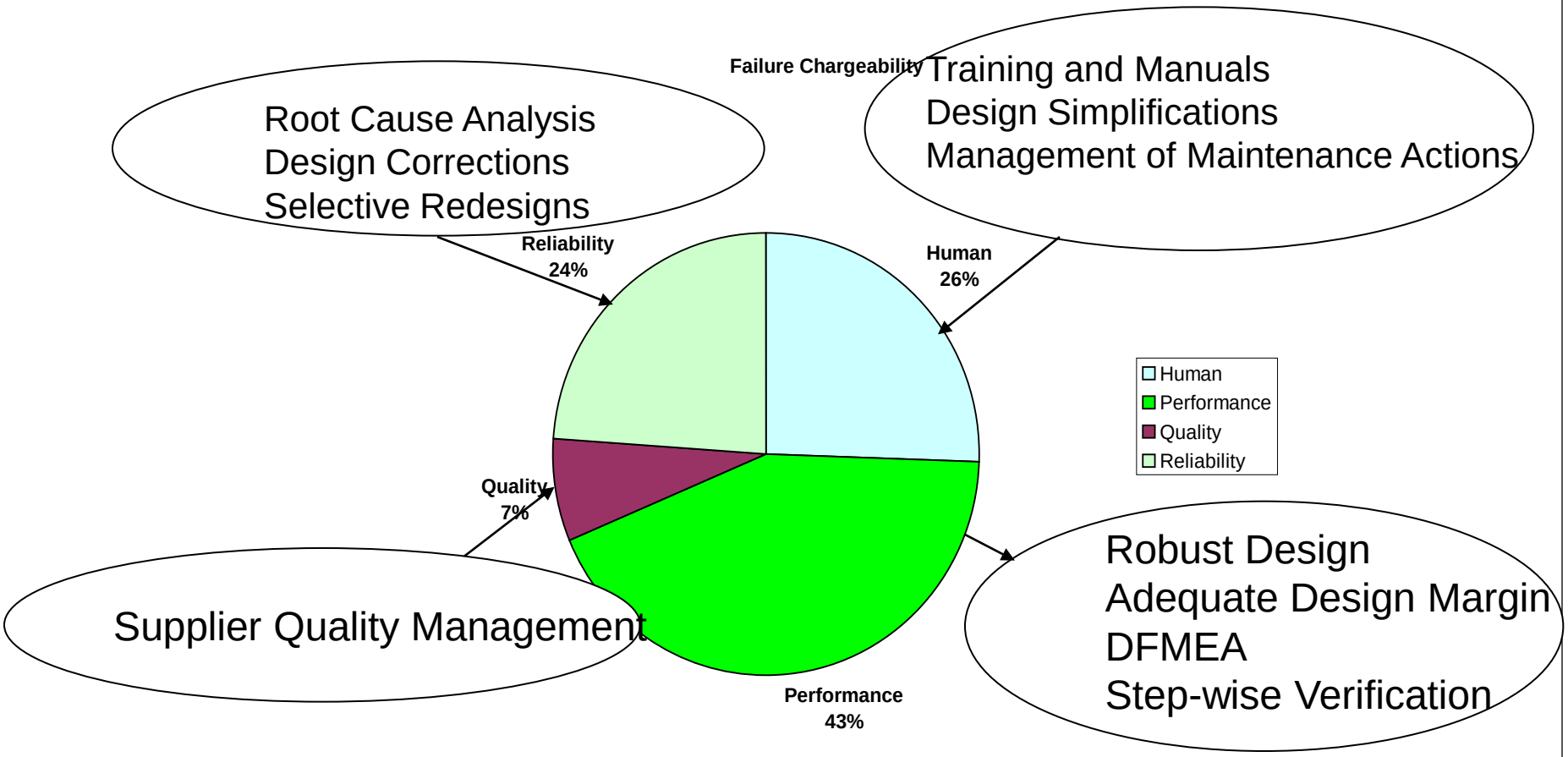
FDSC Scoring Diagram



Failure Mode Categories

- Performance FM – FM is repeatable with 100% probability of failure for the given procedure/conditions. (Example: TDS overheating)
- Software FM – same as above, but software related.
- Quality FM – happens when vehicle is not built/maintained/operated as designed and is not repeatable after fixing (probability of failure =0%). Can be broken down into Initial Quality, Maintenance, Operator error, etc. (Example: Improperly installed harness, turret lock bended, etc.)
- Potential Reliability FM – happens when vehicle was built/maintained/operated as designed/intended; probability of failure is greater than 0% and less than 100%; usually happens due to wear out, environment, insufficient design, manufacturing variability, etc.

Failure Mode Management



Reliability Assessment

- A process of recognizing successful Corrective Action (CA) per failure mode

- Scoring members will evaluate the CA to assess out certain failures based on the proven CA during test

- Fully proven successful CA : 70-80 % assessed out rate

- Assessed Reliability Value will be published in the final
  test report and it is the official Reliability value for the test

Reliability Growth

- What is a Reliability Growth?
- Why Reliability Growth program?
- Reliability Growth during Concept phase
- Reliability Growth during Design phase
- Reliability Growth during Test phase

What is a Reliability Growth?

- Reliability Growth is the increase in the true reliability of a system as a result of failure mode discovery, analysis and effective correction
- Reliability Growth Management is the systematic planning for reliability achievement by controlling the ongoing rate of achievement by the allocation and reallocation of program resources based on comparisons between planned and demonstrated reliability values.
  - Reliability Growth Planning addresses program schedules, amount of testing, resources available, and the realism of the test program in achieving its requirements. Reliability growth planning is portrayed and quantified through a reliability growth planning curve.
  - Reliability Growth Tracking is an area of reliability growth that provides management the opportunity to gauge the progress of the development effort by quantifying the demonstrated reliability of a system throughout its test program.
  - Reliability Growth Projection is an area of reliability growth that focuses on quantifying the reliability that could be achieved if observed failure modes inherent to the system are mitigated by a specified level of fix effectiveness.

Cost of Achieving Reliability

Only ONE way to improve Reliability:

Identify the failure mode, its cause, and remove or mitigate it

Only THREE periods in time to do it:

1. ***After hardware fails in the field***
2. ***After hardware is built but before its fielded***
3. ***Before hardware is built***

Where should **$** and effort be placed?

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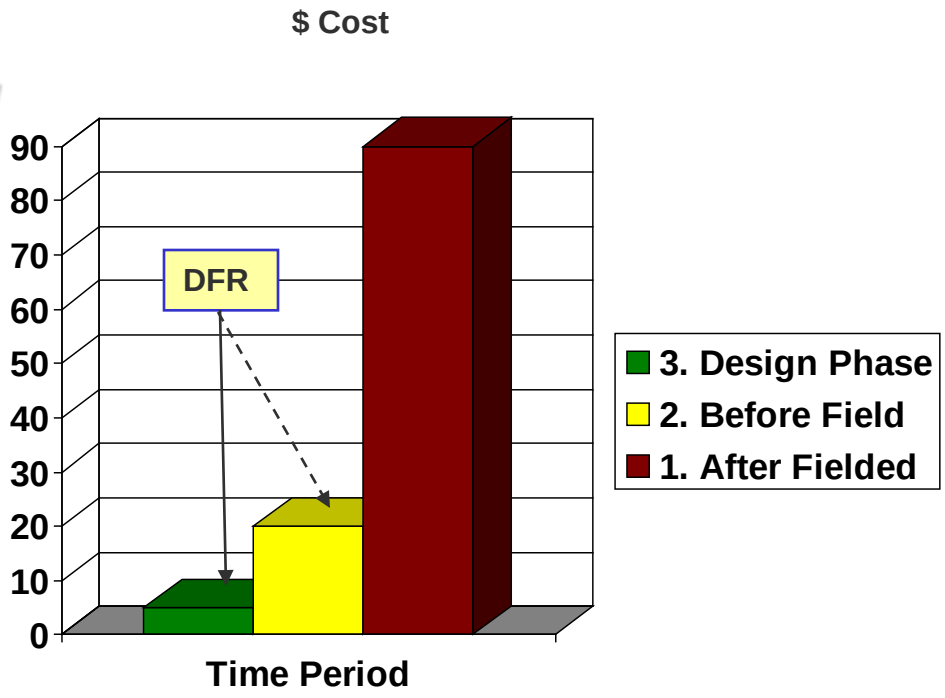
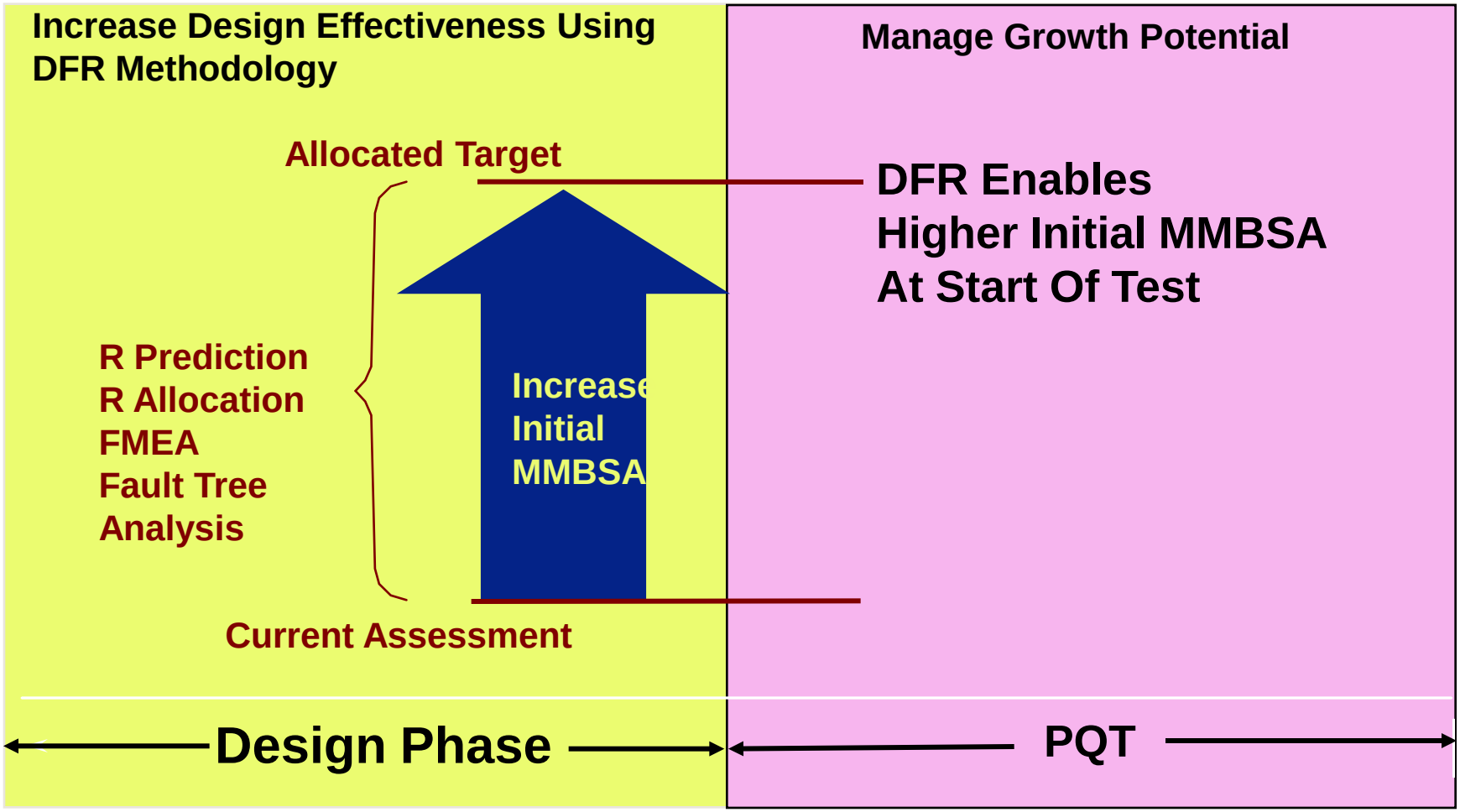


Reliability Growth during Design Phase

- Reliability Growth management during Design Phase
  - Design for Reliability (DFR) is the tool for Reliability Growth during design phase
  - DFR activities (Reliability Program Plan - CDRL)
    - R Prediction
    - R Allocation
    - FMEA
    - Fault Tree Analysis
    - DART Process
  - The growth resulting from DFR activities tracked on the contractor's planning growth curve (Reliability Case Report – CDRL)
  - Results in design and redesign to incorporate corrective action
  - Updating R prediction and allocation

Must Raise Assessment Closer Threshold



Reliability Growth during Test Phase

- Reliability Growth management during Test phase (PQT)
  - Reliability growth through Test, Analyze, Fix and Test (TAFT)
  - Test sample size and test length needs to be sufficient to grow R
  - Failure Analysis Corrective Action Reporting (FACAR) system is a tool for Reliability Growth during test phase
  - Tracking R using Growth Model such as AMSAA/Crow model
  - Provide management an opportunity to gauge the progress of the development effort by quantifying the demonstrated reliability of a system throughout its test
  - If data or test length does not support any growth model, the assessment conference will convene and assess the fix effectiveness of the corrective actions that were implemented

Test-in Reliability